

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 7,175,599 B2
APPLICATION NO. : 10/822181
DATED : February 13, 2007
INVENTOR(S) : Kullervo Hynynen et al.

Page 1 of 20

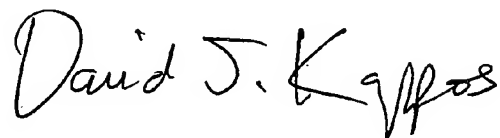
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

The title page should be deleted to appear as per attached title page.

The sheets of drawings consisting of figures 1-26 should be deleted to appear as per attached figures 1-26.

Signed and Sealed this

Sixteenth Day of February, 2010

A handwritten signature in black ink that reads "David J. Kappos". The signature is written in a cursive, flowing style.

David J. Kappos
Director of the United States Patent and Trademark Office

(12) **United States Patent**
Hynynen et al.

(10) **Patent No.:** **US 7,175,599 B2**
(45) **Date of Patent:** **Feb. 13, 2007**

(54) **SHEAR MODE DIAGNOSTIC ULTRASOUND**

(75) Inventors: **Kullervo Hynynen**, Medfield, MA (US); **Gregory T. Clement**, Boston, MA (US)

(73) Assignee: **Brigham and Women's Hospital, Inc.**, Boston, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 315 days.

5,426,979 A * 6/1995 Kantorovich et al. 73/628
5,606,971 A 3/1997 Sarvazyan 128/660.02
5,752,515 A 5/1998 Jolesz et al. 128/653.1
5,810,731 A * 9/1998 Sarvazyan et al. 600/438
6,135,960 A 10/2000 Holmberg 600/447
6,561,981 B2 * 5/2003 Bonnefous 600/443
6,585,647 B1 * 7/2003 Winder 600/437
6,638,219 B1 * 10/2003 Asch et al. 600/437
6,764,448 B2 * 7/2004 Trahey et al. 600/437
6,770,033 B1 * 8/2004 Fink et al. 600/443

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 99/56829 11/1999

(Continued)

OTHER PUBLICATIONS

International Search Report for PCT/US2004/011374, mailing date: Jul. 21, 2004.

(Continued)

(21) Appl. No.: **10/822,181**

(22) Filed: **Apr. 9, 2004**

(65) **Prior Publication Data**
US 2004/0210135 A1 Oct. 21, 2004

Related U.S. Application Data

(60) Provisional application No. 60/463,589, filed on Apr. 17, 2003.

(51) **Int. Cl.**
A61B 8/00 (2006.01)

(52) **U.S. Cl.** **600/443**

(58) **Field of Classification Search** 600/438, 600/440 441, 443, 447, 449 450; 73/625 626
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,996,792 A * 12/1976 Kubota et al. 73/611
4,221,132 A 9/1980 Poole 73/620
4,789,969 A * 12/1988 Naville 367/36
4,817,614 A 4/1989 Hassler et al. 128/660.05
5,197,475 A * 3/1993 Antich et al. 600/437

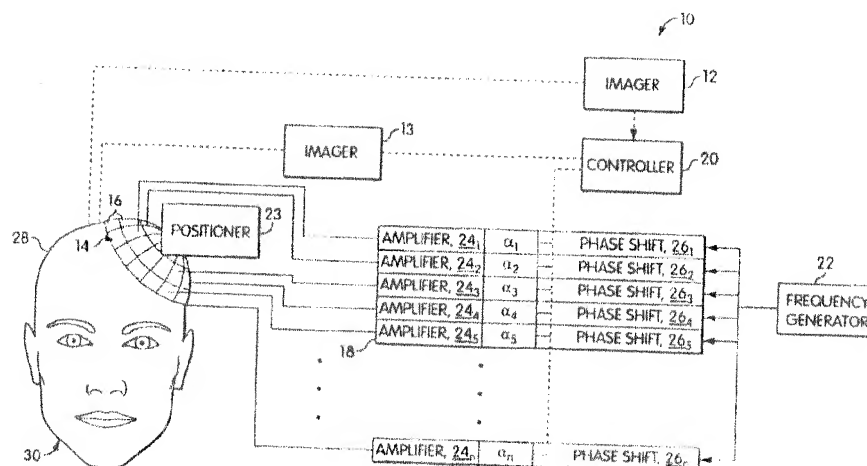
Primary Examiner —Francis J. Jaworski

(74) *Attorney, Agent, or Firm* —Shane H. Hunter; Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C.

(57) **ABSTRACT**

A method of diagnosing a subject by delivering ultrasound signals using shear waves includes applying a portion of an ultrasound mainbeam to a bone surface at an incident angle relative to the surface of the bone to induce shear waves in the bone, energy in the shear waves forming a substantial part of energy of first ultrasound waves at a desired region in the subject through the bone, detecting at least one of reflected and scattered energy of the applied ultrasound mainbeam, and analyzing the detected energy for a diagnostic purpose.

46 Claims, 23 Drawing Sheets



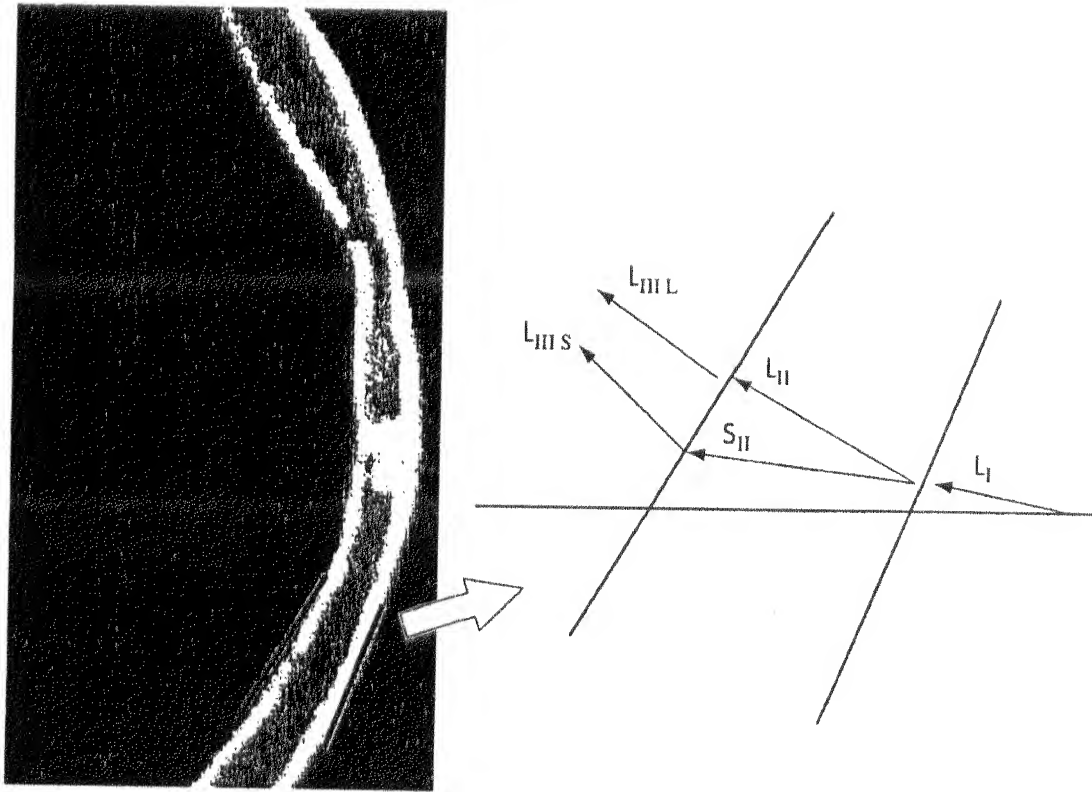


Fig. 1

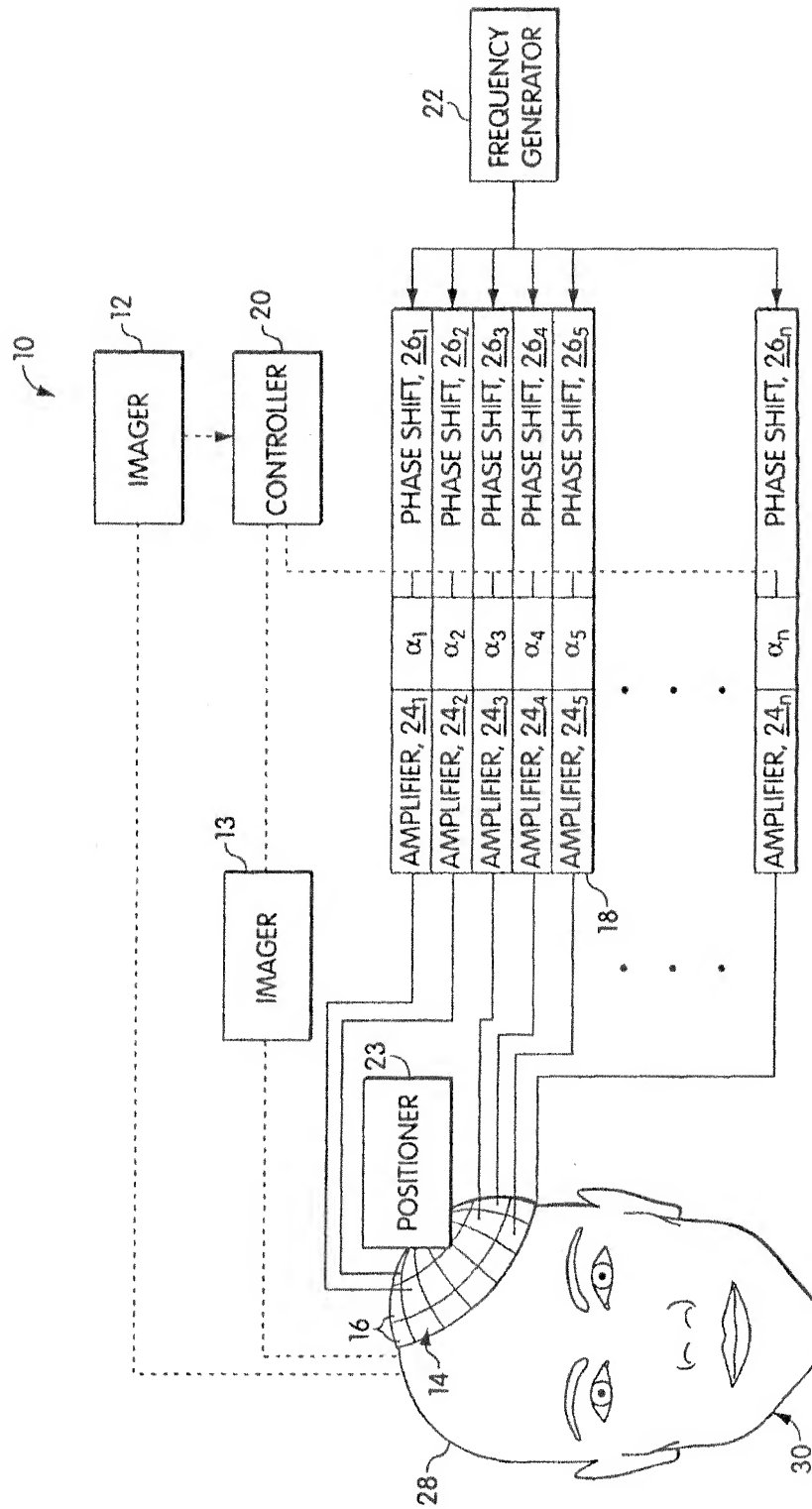


Fig. 2

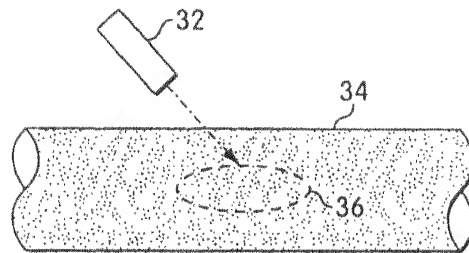


Fig. 3

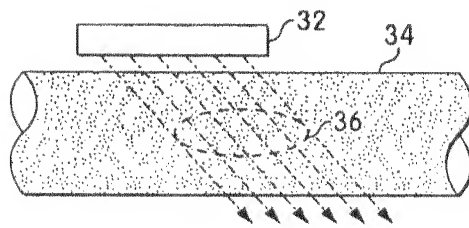


Fig. 4

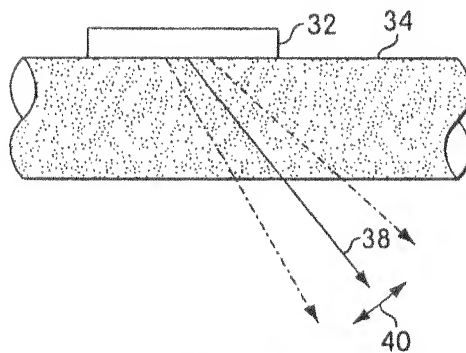


Fig. 5

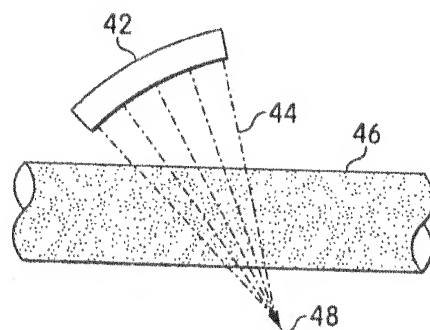


Fig. 6

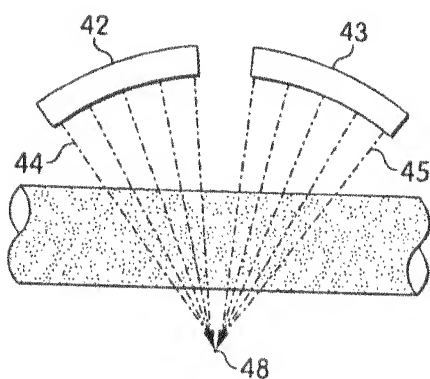


Fig. 7

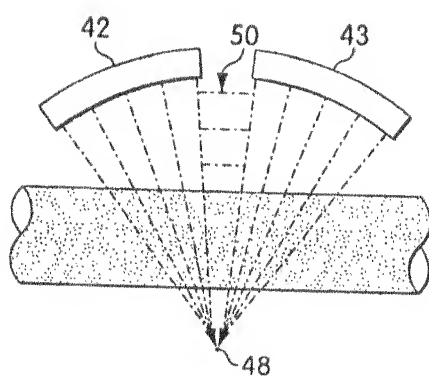


Fig. 8

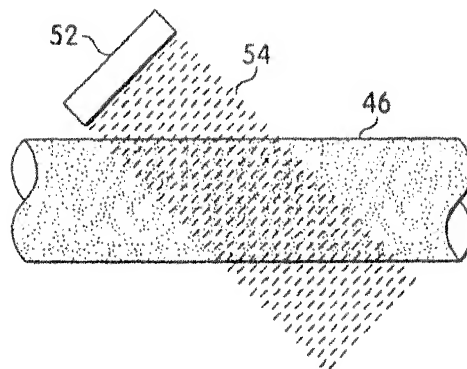


Fig. 9

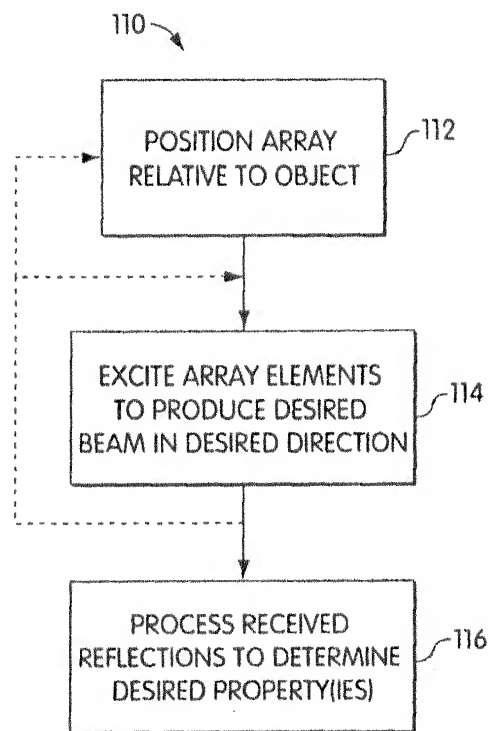


Fig. 10

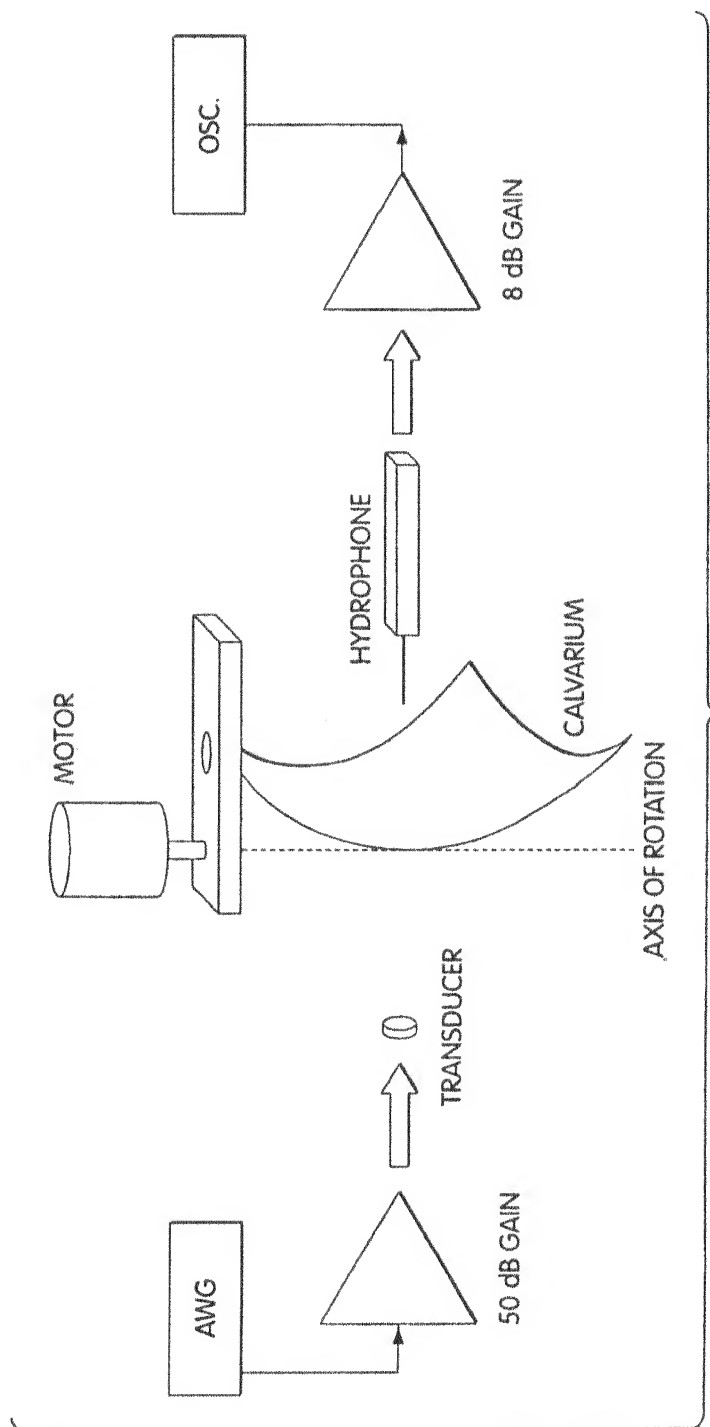


Fig. 11

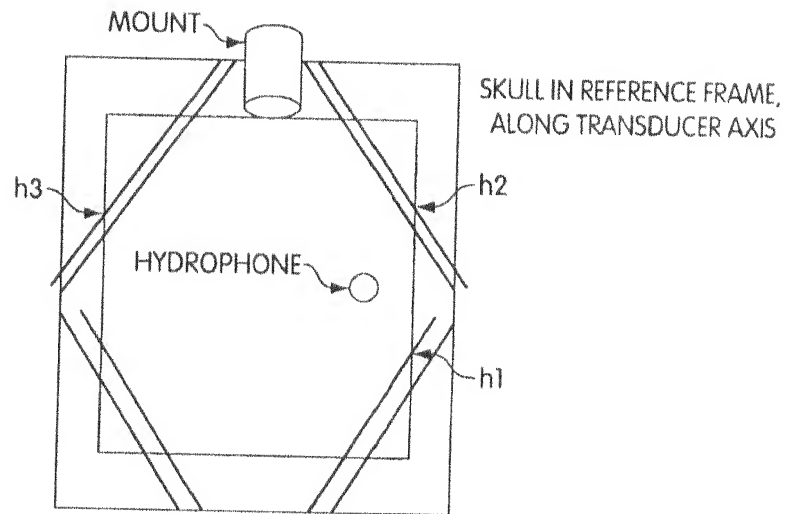


Fig. 12

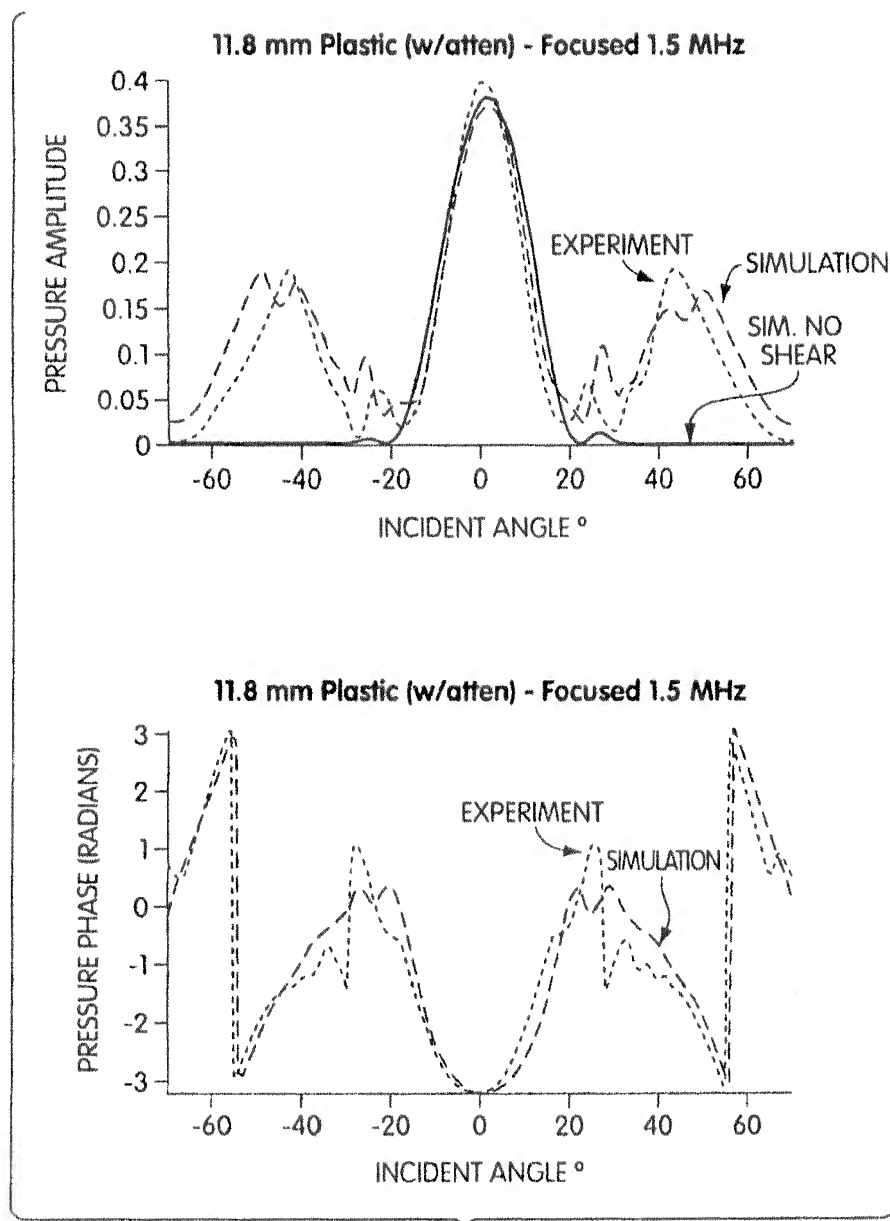


Fig. 13

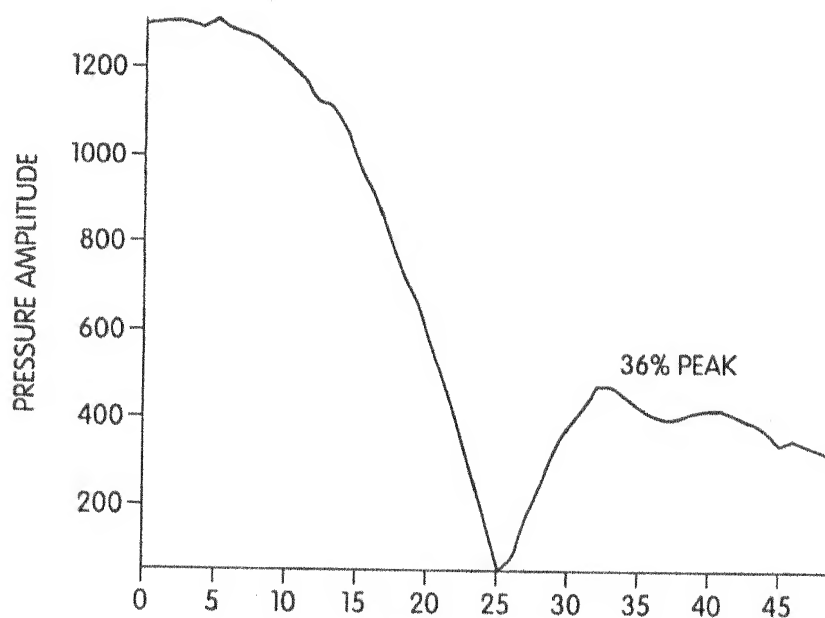


Fig. 14A

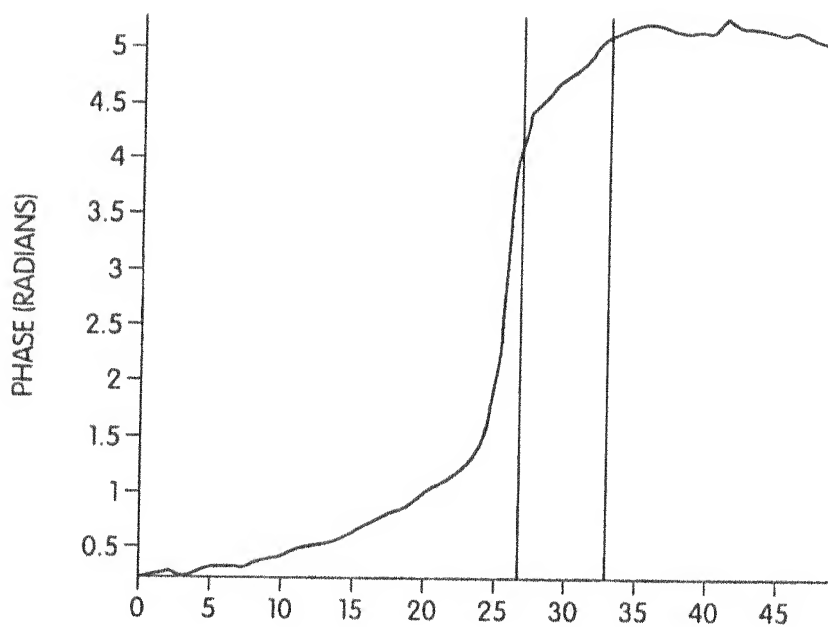
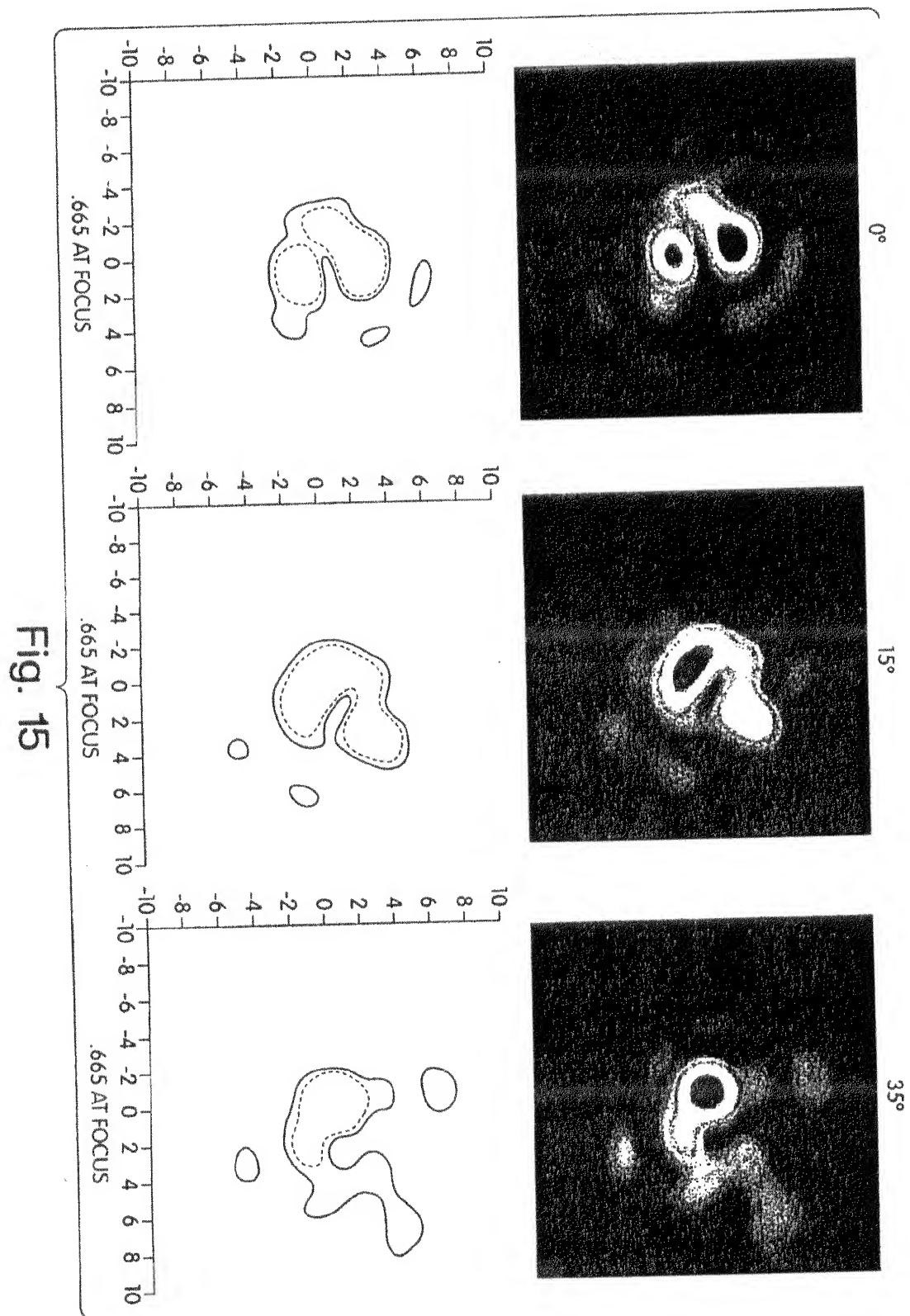


Fig. 14B



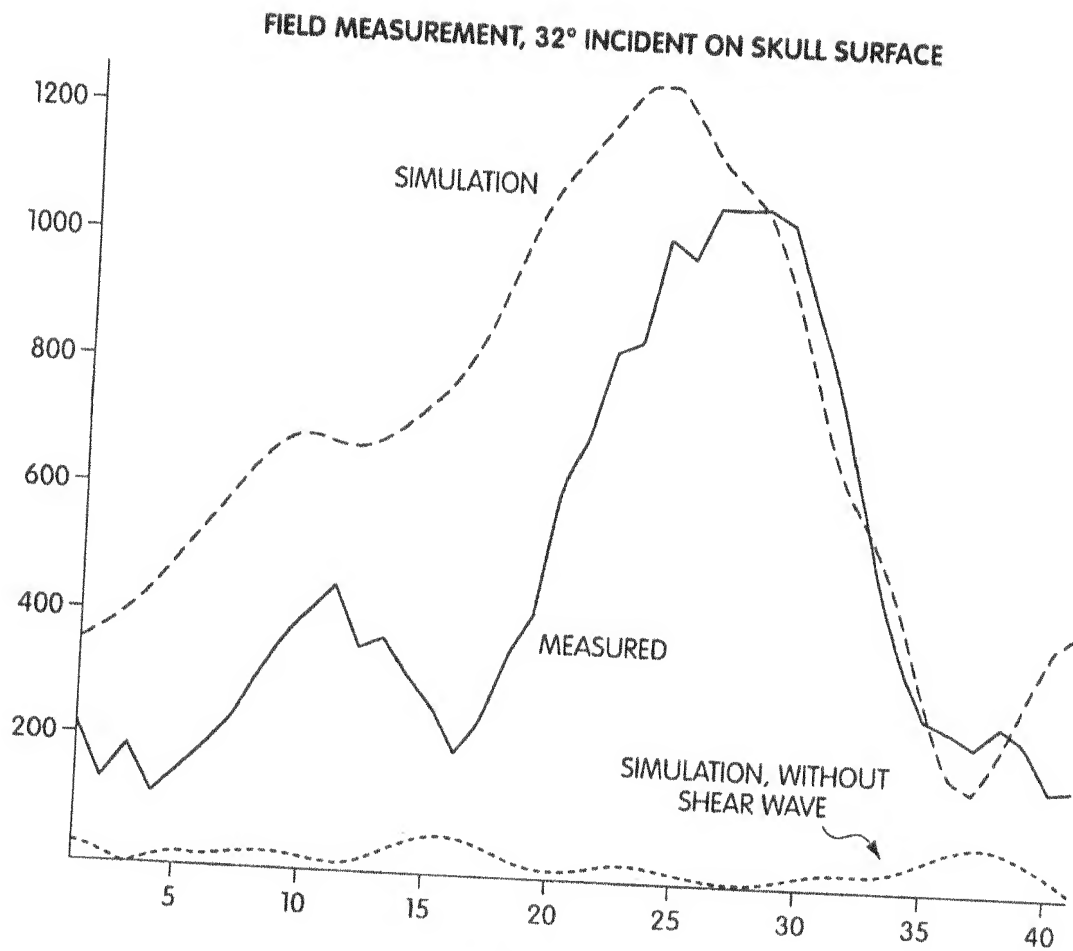


Fig. 16

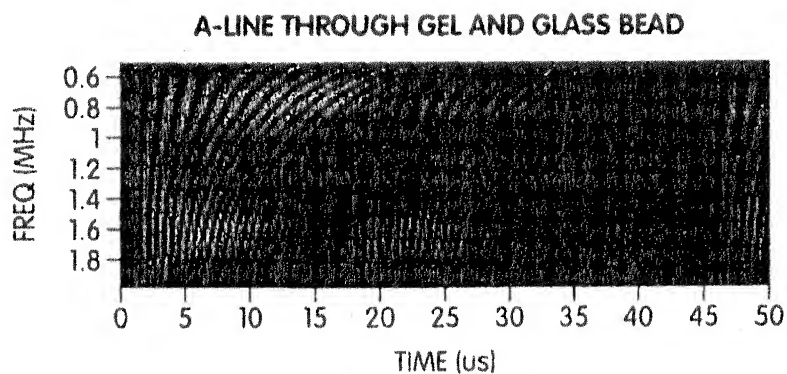


Fig. 17A

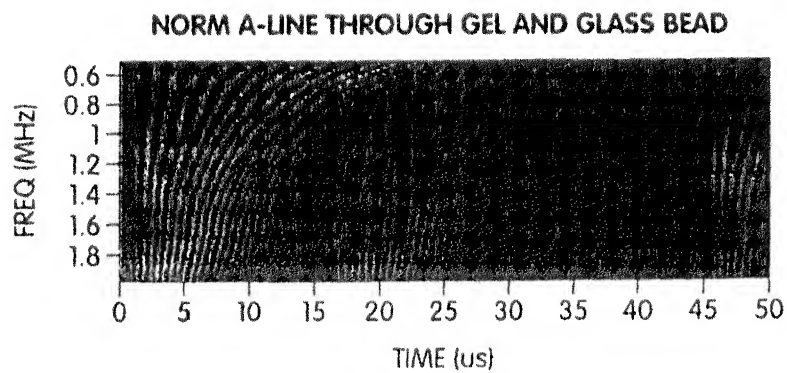


Fig. 17B

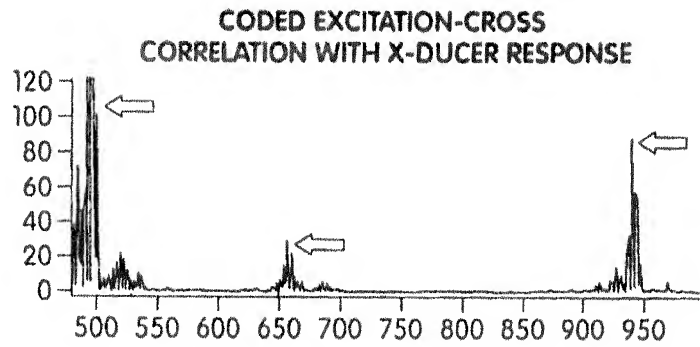


Fig. 18A

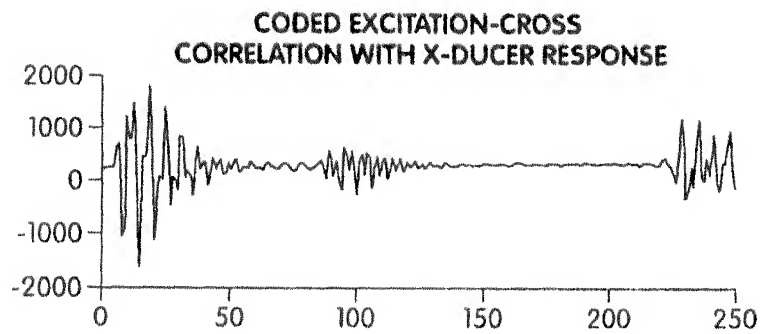


Fig. 18B

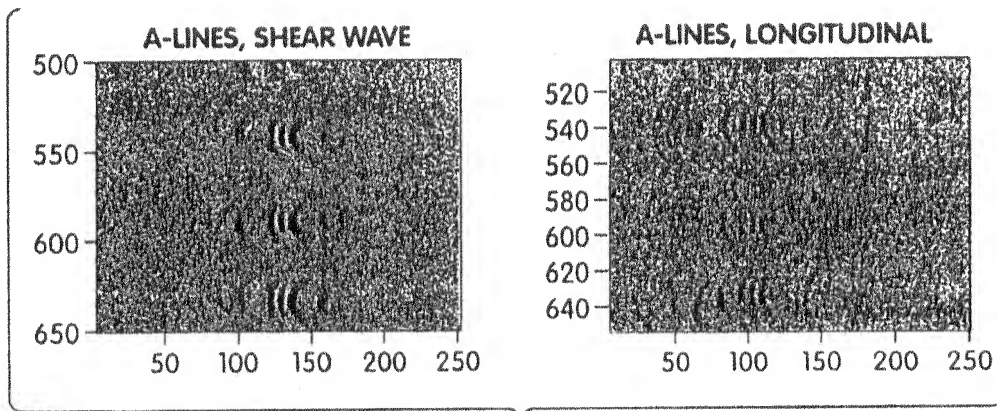


Fig. 19

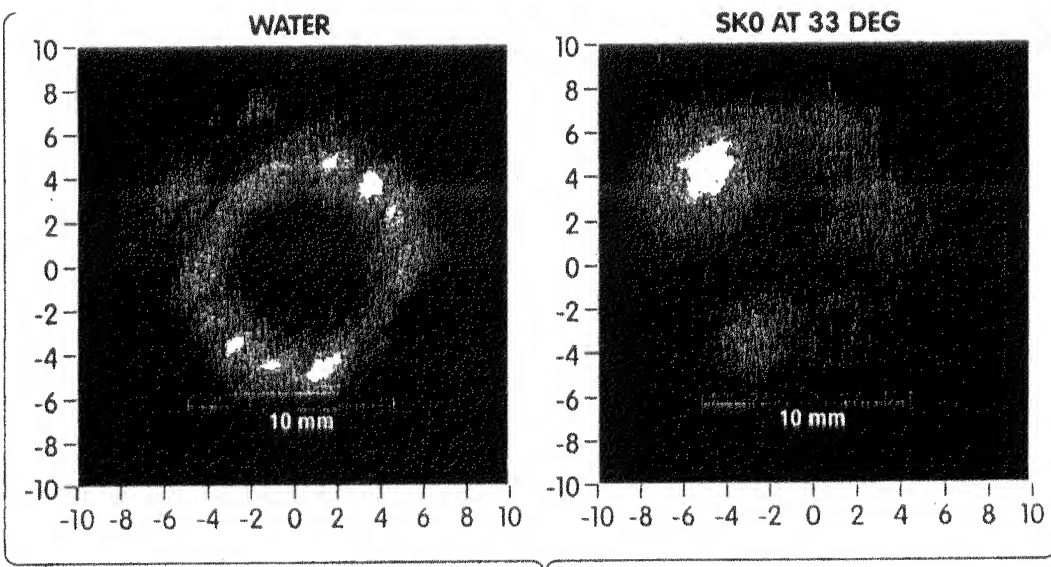


Fig. 20

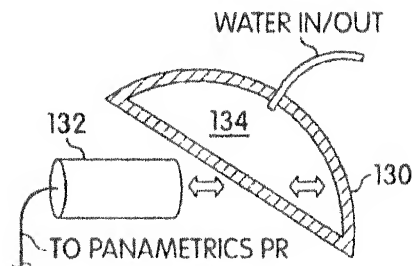
SHEAR IMAGING THROUGH PHANTOM
AT 1 MHz

Fig. 21

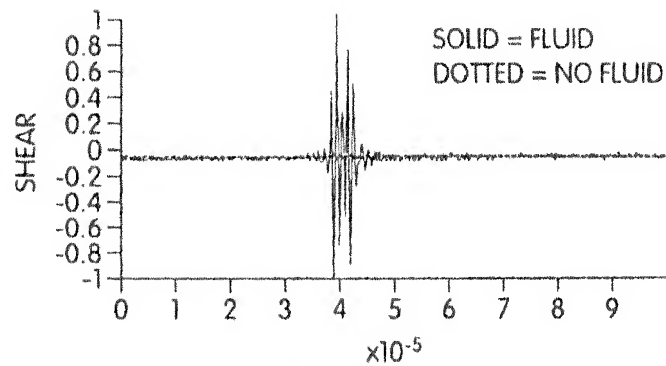


Fig. 22A

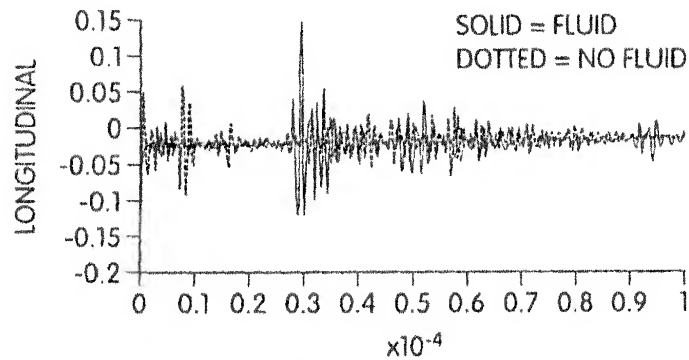


Fig. 22B

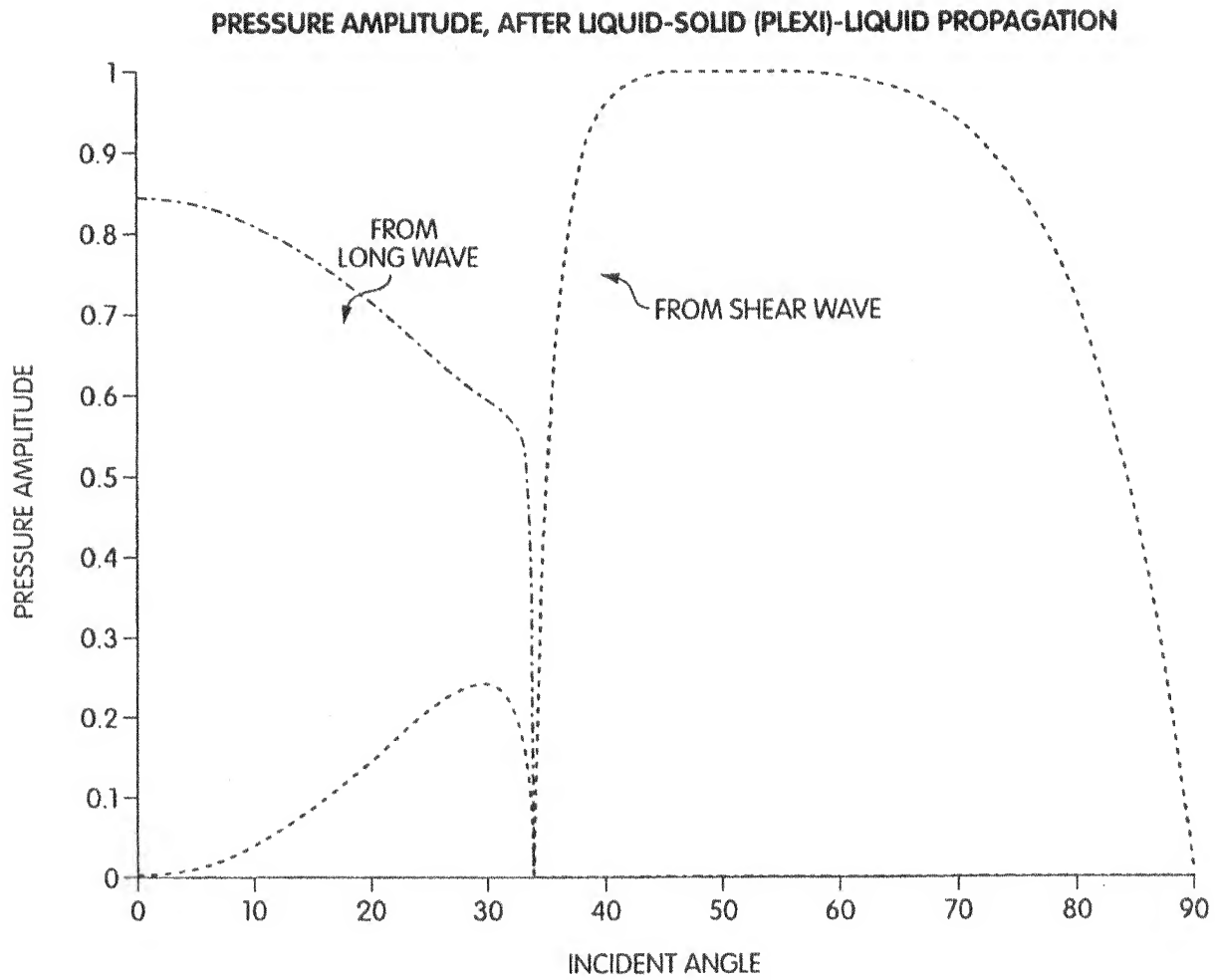


Fig. 23

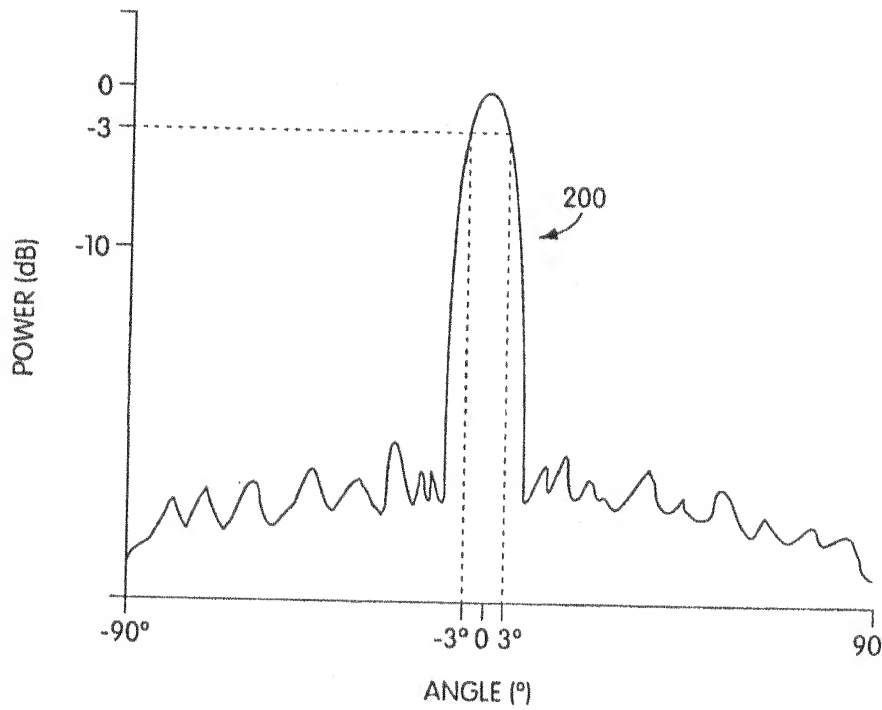


Fig. 24

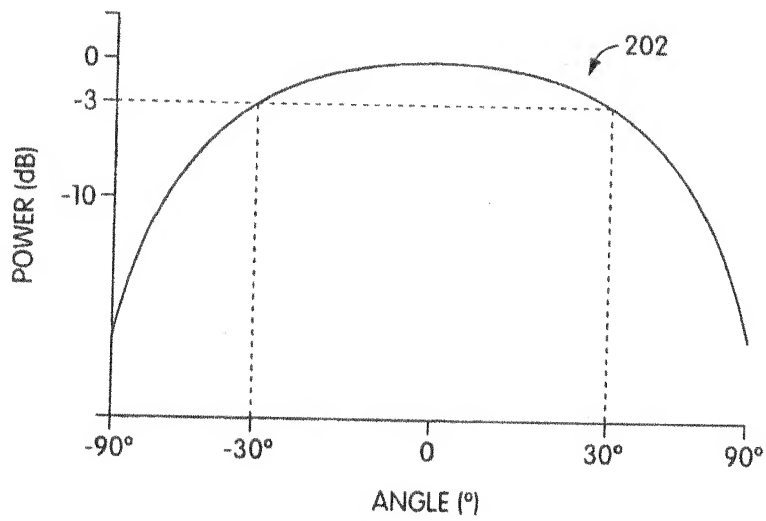


Fig. 25

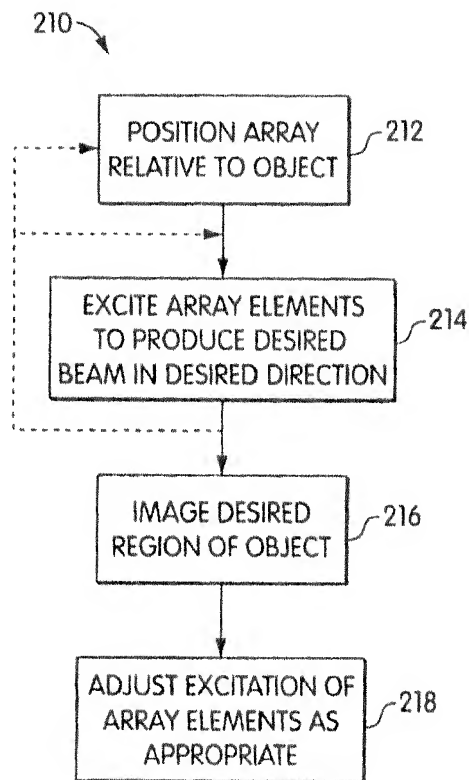


Fig. 26